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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/712,810

11/13/2003

Richard A. Blanchard

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8845

27774

7590

03/14/2006

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EXAMINER

LE, THAO X

ART UNIT

PAPER NUMBER

2814

DATE MAILED: 03/14/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

51

Office Action Summary	Application No.		Applicant(s)	
	10/712,810		BLANCHARD ET AL.	
	Examiner		Art Unit	
	Thao X. Le		2814	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 13 November 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 24-41 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 24-26 is/are allowed.
- 6) ☒ Claim(s) 27-41 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date <u>11/23/03</u> | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 27-29, 32-36, 38-41 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 4893160 to Blanchard in view of US 5216275 to Chen.

Regarding claim 27, Blanchard discloses a power semiconductor device in fig. 4j comprising: a substrate 11 of a first conductivity type (N); a voltage sustaining region 12 disposed on said substrate, said voltage sustaining region including an epitaxial layer 12, col. 2 line 10, having a first conductivity type (N); at least one terraced trench 36 located in said epitaxial layer 12, said terraced trench 36 having a plurality of portions

that differ in width to define at least one annular ledge therebetween; at least one annular doped region 39 having a dopant of a conductivity N-type, said annular doped region being located in said epitaxial layer 12 below and adjacent to said annular ledge; a filler material 40/42 substantially filling said terraced trench; and at least one active region 15 of said second conductivity P disposed over said voltage sustaining region 12 to define a junction therebetween.

But, Blanchard does not disclose at least one annular doped region having a dopant of a second conductivity type.

However, Chen discloses a power semiconductor device in fig. 6 comprises a n-type substrate 4, a n-type epitaxial layer 5 a trench having either n or p-type conductivity region 6, col. 5 line 55. At the time the invention was made; it would have been obvious to one of ordinary skill in the art to use the doping teaching of Chen with Blanchard's device, because it would have created a device with better on-voltage and breakdown voltage as taught by Chen in col. 1 lines 58-63.

Regarding claims 28-29, Blanchard discloses the device wherein said plurality of portions of the terraced trench includes a smallest width portion and a largest width portion, said smallest width portion being located at a depth in said epitaxial layer such that it is closer to the substrate than a largest width portion, fig. 4j, wherein said plurality of portions of the terraced trench are coaxially located with respect to one another, fig. 4j.

Regarding claim 32, Blanchard discloses the device wherein said epitaxial layer has a given thickness and further comprising the step of etching a first portion of the terraced trench by an amount

But, Blanchard does not disclose the etching is substantially equal to $1/(x+1)$ of said given thickness, where x is equal to or greater than a prescribed number of annular doped regions to be formed in the voltage sustaining region. Accordingly, it would have been obvious to one of ordinary skill in art to the trench etching of Blanchard in the range as claimed, because it has been held that where the general conditions of the claims are disclosed in the prior art, it is not inventive to discover the optimum or workable range by routine experimentation. See *In re Aller*, 220 F.2d 454, 105 USPQ 233, 235 (CCPA 1955).

Regarding claims 33-34, Blanchard discloses the power semiconductor device wherein said material filling the trench is a silicon dioxide dielectric material 40.

Regarding claim 35, Blanchard does not disclose the dielectric material is silicon nitride.

However, at the time the invention was made, it would have been obvious to one of ordinary skill in the art to replace the layer 40 of silicon nitride material, because both silicon dioxide and silicon nitride can be used interchangeably as a dielectric and would have been considered a mere substitution of art-recognized equivalent values, MPEP 2144.06.

Regarding claim 36, Blanchard does not disclose a dopant is boron. However, as discussed in the claim 27 above, Chen discloses the layer 6 can be N or P-type doping. Thus, using boron for P-type conductivity or phosphorus for N-type doping is standard in the art.

Regarding claims 38-39, Blanchard discloses the device wherein said at least one active region further a gate dielectric 40 and a gate conductor 42 disposed above said gate dielectric 40; first and second body regions 15a/15b located in the epitaxial layer 12 to define a drift region therebetween, said body regions 15a/15b having a second conductivity type; and first and second source regions 16a/16b of the first conductivity type located in the first and second body regions, respectively, fig. 4j, wherein said body regions include a deep body regions p+, fig. 4j.

Regarding claims 40-41, Blanchard does not disclose the device wherein said terraced trench has a circular cross-section or cross-sectional shape selected from the group consisting of a square, rectangle, octagon, and a hexagon.

However, Chen discloses the device wherein said trench has a circular cross-section or cross-sectional shape selected from the group consisting of a square, rectangle, octagon, and a hexagon, fig. 3. At the time the invention was made; it would have been obvious to one of ordinary skill in the art to use the cross-sectioned shape teaching of Chen with Blanchard's device, because it would have created a device with better on-voltage and breakdown voltage as taught by Chen in col. 1 lines 58-63.

4. Claims 30-31 and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 4893160 to Blanchard and US 5216275 to Chen as applied to claim 27 above, and further in view of US 6078078 to Gardner.

Regarding claim 30, Blanchard discloses the device wherein said plurality of portions of the terraced trench includes at least two annular ledges and said at least one annular doped region includes at least two annular doped regions, fig. 4j.

But, Blanchard does not disclose the device wherein said plurality of portions of the terraced trench includes at least three portions that differ in width from one another.

However, Gardner discloses a V-gate transistor in fig. 10 comprising a plurality of portions of the terraced trench includes at least three portions that differ in width from one another. At the time the invention was made; it would have been obvious to one of ordinary skill in the art to use the teaching of Gardner with Blanchard's device, because it would have higher packing density for a given substrate as taught by Gardner, see abstract.

Regarding claim 37, Blanchard discloses the device wherein a surface area of the at least two annular ledges are substantially equal to one another.

Allowable Subject Matter

5. Claims 24-26 are allowed because the prior art of record neither anticipated nor rendered obvious all the limitation of the base claim 24-26 including implating a dopant

of a second conductivity type through the barrier material lining said at least one annual ledge and said trench bottom and into adjacent portion of the epitaxial layer.

Conclusion

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thao X. Le whose telephone number is (571) 272-1708. The examiner can normally be reached on M-F from 8:00 AM - 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael M. Fahmy can be reached on (571) 272 -1705. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Thao X. Le
09 Feb. 2006